AMENDMENTS TO THE CLAIMS

The following listing of claims will replace all prior versions and listings of claims in the application.

LISTING OF CLAIMS

1. (Previously presented) A droplet ejection apparatus having a driving circuit and a plurality of droplet ejection heads, each of the droplet ejection heads including a cavity filled with a liquid, a nozzle communicated with the cavity, an actuator driven by the driving circuit, and a diaphragm displaced by the actuator, the droplet ejection head ejecting the liquid within the cavity through the nozzle in the form of droplets by driving the actuator with the driving circuit, the droplet ejection apparatus comprising:

ejection failure detecting and recovery processing determining means which detects a residual vibration of the diaphragm at least when the apparatus is powered on, and then detects an ejection failure of the droplet ejection heads on the basis of a vibration pattern of the detected residual vibration of the diaphragm and determines recovery processing for eliminating the ejection failure; and

recovery means for carrying out the recovery processing determined by the ejection failure detecting and recovery processing determining means;

wherein:

the ejection failure detecting and recovery processing determining means identifies a cause of the ejection failure of the droplet ejection heads on the basis of the vibration pattern of the residual vibration of the diaphragm;

the vibration pattern of the residual vibration of the diaphragm includes a cycle of the residual vibration; and

the ejection failure detecting and recovery processing determining means judges that: an air bubble has intruded into the cavity in the case where the cycle of the residual vibration of the diaphragm is shorter than a predetermined range of cycle; the liquid in the vicinity of the nozzle has thickened due to drying in the case where the cycle of the residual vibration of the diaphragm is longer than a predetermined threshold; and paper dust is adhering in the vicinity of the outlet of the nozzle in the case where the cycle of the residual vibration of the diaphragm is longer than the predetermined range of cycle and shorter than the predetermined threshold.

2. (Original) The droplet ejection apparatus as claimed in claim 1, wherein the ejection failure detecting and recovery processing determining means detects the ejection failure of the droplet ejection heads on the basis of a vibration pattern of the residual vibration of the diaphragm when the actuator is driven by the driving circuit to such an extent that a droplet is not ejected, and determines the recovery processing for eliminating the ejection failure.

3. (Cancelled)

4. (Previously presented) The droplet ejection apparatus as claimed in claim 1, wherein the ejection failure detecting and recovery processing determining means determines the recovery processing for eliminating the cause of the ejection failure of the droplet ejection heads according to the cause of the ejection failure in the case where the ejection failure of the droplet ejection heads is detected.

5. (Original) The droplet ejection apparatus as claimed in claim 1, wherein the recovery means includes: wiping means for carrying out a wiping process in which a nozzle surface of the droplet ejection heads where the nozzles are arranged is wiped with a wiper; flushing means for carrying out a flushing process by which the droplets are preliminarily ejected through the nozzles of the droplet ejection heads by driving the actuator; and pumping means for carrying out a pump-suction process with the use of a pump connected to a cap that covers the nozzle surface of the droplet ejection heads.

6. (Original) The droplet ejection apparatus as claimed in claim 5, wherein the ejection failure detecting and recovery processing determining means selects the pump-suction process as the recovery processing for eliminating the cause of the ejection failure in the case where it is judged that the cause of the ejection failure of the droplet ejection heads is intrusion of an air bubble into the cavity.

7. (Original) The droplet ejection apparatus as claimed in claim 5, wherein the ejection failure detecting and recovery processing determining means selects at least the wiping process as the recovery processing for eliminating the cause of the ejection failure in the case where it is judged that the cause of the ejection failure of the droplet ejection heads is adhesion of paper dust in the vicinity of an outlet of the nozzle.

8. (Original) The droplet ejection apparatus as claimed in claim 5, wherein the ejection failure detecting and recovery processing determining means selects the

flushing process or the pump-suction process as the recovery processing for eliminating the cause of the ejection failure in the case where it is judged that the cause of the ejection failure of the droplet ejection heads is thickening of the liquid in the vicinity of the nozzle due to drying.

9. (Original) The droplet ejection apparatus as claimed in claim 5, wherein the ejection failure detecting and recovery processing determining means selects the flushing process as the recovery processing for eliminating the cause of the ejection failure in the case where it is judged that the cause of the ejection failure of the droplet ejection heads is thickening of the liquid in the vicinity of the nozzle due to drying.

10. (Original) The droplet ejection apparatus as claimed in claim 9, wherein the ejection failure detecting and recovery processing determining means selects the pump-suction process as the recovery processing for eliminating the cause of the ejection failure in the case where the ejection failure is not eliminated even by carrying out the flushing process by the flushing means predetermined times.

11. (Original) The droplet ejection apparatus as claimed in claim 10, further comprising informing means for informing the fact that the ejection failure has not been eliminated in the case where the ejection failure is not eliminated even by carrying out the pump-suction process by the pumping means predetermined times.

12. (Cancelled)

13. (Cancelled)

14. (Cancelled)

15. (Cancelled)

16. (Previously presented) The droplet ejection apparatus as claimed in claim 1, wherein the ejection failure detecting and recovery processing determining means includes an oscillation circuit and the oscillation circuit oscillates in response to an electric capacitance component of the actuator that varies with the residual vibration of the diaphragm, and wherein the ejection failure detecting and recovery processing determining means includes a resistor element connected to the actuator, and the oscillation circuit forms a CR oscillation circuit based on the electric capacitance component of the actuator and a resistance component of the resistor element.

17. (Previously presented) The droplet ejection apparatus as claimed in claim 16, wherein the ejection failure detecting and recovery processing determining means includes an F/V converting circuit that generates a voltage waveform in response to the residual vibration of the diaphragm from a predetermined group of signals generated based on changes in an oscillation frequency of an output signal from the oscillation circuit.

18. (Original) The droplet ejection apparatus as claimed in claim 17, wherein the ejection failure detecting and recovery processing determining means includes a waveform shaping circuit that shapes the voltage waveform in response to the residual vibration of the diaphragm generated by the F/V converting circuit into a predetermined waveform.

19. (Original) The droplet ejection apparatus as claimed in claim 18, wherein the waveform shaping circuit includes: DC component eliminating means for eliminating a direct current component from the voltage waveform of the residual vibration of the diaphragm generated by the F/V converting circuit; and a comparator that compares the voltage waveform from which the direct current component thereof has been eliminated by the DC component eliminating means with a predetermined voltage value; and

wherein the comparator generates and outputs a rectangular wave based on this voltage comparison.

20. (Original) The droplet ejection apparatus as claimed in claim 19, wherein the ejection failure detecting and recovery processing determining means includes measuring means for measuring the cycle of the residual vibration of the diaphragm based on the rectangular wave generated by the waveform shaping circuit.

21. (Original) The droplet ejection apparatus as claimed in claim 20, wherein the measuring means has a counter, and measures either a time between rising edges of

the rectangular wave or a time between a rising edge and falling edge of the rectangular wave by counting pulses of a reference signal with the counter.

22. (Original) The droplet ejection apparatus as claimed in claim 1, wherein the actuator includes an electrostatic actuator.

23. (Original) The droplet ejection apparatus as claimed in claim 1, wherein the actuator includes a piezoelectric actuator having a piezoelectric element and using a piezoelectric effect of the piezoelectric element.

24. (Original) The droplet ejection apparatus as claimed in claim 1, wherein the actuator includes a film boiling actuator provided with a heating element that generates heat when an electric current flows therethrough.

25. (Previously presented) The droplet ejection apparatus as claimed in claim 1, wherein the diaphragm deforms elastically so as to follow a change in the internal pressure of the cavity.

26. (Original) The droplet ejection apparatus as claimed in claim 1, further comprising:

storage means for storing a cause of the ejection failure of the droplets detected by the ejection failure detecting and recovery processing determining means in association with the droplet ejection head for which the detection was carried out.

27. (Original) The droplet ejection apparatus as claimed in claim 1, wherein the droplet ejection apparatus includes an ink jet printer.

28. (Previously presented) A droplet ejection apparatus having a driving circuit and a plurality of droplet ejection heads, each of the droplet ejection heads including a cavity filled with a liquid, a nozzle communicated with the cavity, an actuator driven by the driving circuit, and a diaphragm displaced by the actuator, the droplet ejection head ejecting the liquid within the cavity through the nozzle in the form of droplets by driving the actuator with the driving circuit, the droplet ejection apparatus comprising:

ejection failure detecting and recovery processing determining means which detects a residual vibration of the diaphragm at least when the apparatus is powered on, and then detects an ejection failure of the droplet ejection heads on the basis of a vibration pattern of the detected residual vibration of the diaphragm and determines recovery processing for eliminating the ejection failure; and

recovery means for carrying out the recovery processing determined by the ejection failure detecting and recovery processing determining means;

wherein the ejection failure detecting and recovery processing determining means includes an oscillation circuit that oscillates in response to an electric capacitance component that varies with the residual vibration of the diaphragm.

29. (Previously presented) A droplet ejection apparatus having a driving circuit and a plurality of droplet ejection heads, each of the droplet ejection heads including a

cavity filled with a liquid, a nozzle communicated with the cavity, an actuator driven by the driving circuit, and a diaphragm displaced by the actuator, the droplet ejection head ejecting the liquid within the cavity through the nozzle in the form of droplets by driving the actuator with the driving circuit, the droplet ejection apparatus comprising:

ejection failure detecting and recovery processing determining means which detects a residual vibration of the diaphragm at least when the apparatus is powered on, and then detects an ejection failure of the droplet ejection heads on the basis of a vibration pattern of the detected residual vibration of the diaphragm and determines recovery processing for eliminating the ejection failure; and

recovery means for carrying out the recovery processing determined by the ejection failure detecting and recovery processing determining means;

wherein the ejection failure detecting and recovery processing determining means includes an oscillation circuit that oscillates in response to an electric capacitance component of the actuator that varies with the residual vibration of the diaphragm.